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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention attains large storage capacity-ization using the laser beam of an optical recording medium, optical recording playback equipment (the optical recording playback equipment in this specification shall carry out the designation of the device which performs the reproduction or/and record over an optical recording medium and which is performed optically), the especially blue wavelength range, blue, and red.
[0002]
[Description of the Prior Art]Although the feature in the case of taking a disk gestalt as an optical recording medium has an advantage which can constitute the speed of access, and a small and simple recording and reproducing device, For example, in order the record reproduction of NTSC 4 hours is possible on one side and to realize the disk which changes to the present videotape recorder (VTR), the storage capacity more than 8 GB (G byte) is required.
[0003]
[Problem(s) to be Solved by the Invention]The optical recording medium with which this invention enabled it for the storage capacity to be not less than 8 GB and which makes basic constitution the optical disc which has the ROM (Read Only Memory) section in part at least, It sets it as the main purpose to provide the optical recording playback equipment which performs the reproduction or/and record over this optical recording medium and which is performed optically.
[0004]
[Means for Solving the Problem]As for an optical recording medium by this invention, a light transmission layer is formed on an information storage side in which an information storage pit was formed, The wavelength lambda from this light transmission layer side a 380 nm<=lambda

<=450nm laser beam, . He glares through a 0.76 or more N.A. (numerical aperture) lens system, and read-out of the above-mentioned information should do. Thickness of the light transmission layer shall be 3 micrometers - 182 micrometers, and thickness unevenness of a light transmission layer, Less than **5.26lambda/(N.A.) ^{4} carries out, and a track pitch, It is referred to as 0.27 micrometer - 0.404 micrometer, and shortest pit length of an information storage pit sets to 0.13 micrometer - 0.219 micrometer, and makes recording linear density a pit sequence of 0.146micrometer/bit or less, and it has the composition which sets the depth of a record pit to 31 nm - 75 nm.

[0005]An optical recording medium by this invention mentioned above is used for optical recording playback equipment by this invention, The wavelength lambda leads a 380 nm<=lambda <=450nm laser beam, and N.A. leads 0.76 or more optical systems, and a laser beam is entered into an optical recording medium from that light transmission layer side, and it has the composition which reproduces recorded information on this information storage side.

[0006]A light transmission layer is formed on an information storage side, a laser beam exposure is made, an information storage side is laminated via an interlayer according [1st at least one or more information storage sides and the 2nd information storage side] to a light transmission layer respectively, and an optical recording medium by this invention comprises this light transmission layer side. The sum of thickness of a light transmission layer which intervenes between entrance planes of a laser beam from these each information storage side, and an interlayer shall be 3 micrometers - 182 micrometers. That is, when the thickness shall be 3 micrometers - 182 micrometers when only a light transmission layer intervenes between entrance planes of a laser beam from an information storage side, and a light transmission layer and an interlayer intervene, the sum of such thickness shall be 3 micrometers - 182 micrometers. And less than **5.26lambda/(N.A.) ^{4} carries out thickness unevenness of an entrance plane and all the information storage layers. And a track pitch of the 1st information storage side shall be 0.27 micrometer - 0.404 micrometer, and a track pitch of the 2nd information storage side shall be 0.45 micrometer - 0.57 micrometer. And the wavelength lambda to the 1st information storage side. A laser beam which is 380 nm<=lambda <=450nm, It glares through a 0.76 or more N.A. (numerical aperture) optical system, and the wavelength lambda to the 2nd information storage side. It irradiates with a laser beam which is 635 nm<=lambda <=680nm through a 0.76 or more N.A. (numerical aperture) optical system, and it is considered as composition of record or reproduction which makes either at least, respectively.

[0007]The wavelength lambda optical recording playback equipment by this invention using an optical recording medium which has the 1st and 2nd information storage sides mentioned above. The 1st laser beam that is 380 nm<=lambda <=450nm, The wavelength lambda. Through a 0.76 or more N.A. (numerical aperture) optical system, an information storage side

of the above 1st and the 2nd information storage side are irradiated with the 2nd laser beam that is 635 nm<=lambda <=680nm, respectively, and it is considered as composition of record or reproduction which performs at least any they are, respectively.

[0008]By having above-mentioned composition, mass storage capacity-ization of not less than 8 GB is enabled.

[0009]

[Embodiment of the Invention]As the embodiment of 1 of the optical recording medium by this invention shows drawing 1 the outline sectional view, the light transmission layer 12 is formed on the information storage side 11A where the information storage pit 13 was formed in one field of the substrate 10 by plastic plate, metal substrate, a glass substrate, etc.

[0010]By transferring detailed unevenness of the desired patterns formed in this from the stamper which formed the substrate 10, for example with the injection molding by polycarbonate (PC), and has been arranged in a molding metal mold simultaneously with the molding, The so-called formation of the information storage pit 13 mentioned above to the field which is one side, for example, and also a groove is made.

[0011]The thickness of this substrate 10 can be selected in thickness of less than 1.2 mm which sets to 0.3 mm or more in which injection molding is possible, for example, and is equivalent to the thickness of the substrate in CD etc.

[0012]Thickness t of the light transmission layer 12 sets to 3 micrometers - 182 micrometers, and less than **5.26lambda/(N.A.) ^{4} carries out the thickness unevenness deltat.

[0013]And the laser beam which performs reproduction or/, and record is entered from this light transmission layer 12 side.

[0014]Blue or the wavelength range lambda not more than this, i.e., wavelength, makes this laser beam a 380 nm<=lambda <=450nm laser beam, and it irradiates with it through a 0.76 or more N.A. (numerical aperture) lens system, for example, read-out of information, i.e., reproduction, is made.

[0015]Track pitch TP of the information storage side may be 0.27 micrometer - 0.404 micrometer. Shortest pit length P_{min} of an information storage pit may be 0.13 micrometer - 0.219 micrometer. Recording linear density LD is taken as a pit sequence of 0.146micrometer/bit or less. Depth D of an information storage pit may be 31 nm - 75 nm.

[0016]Thickness t of a light transmission layer may be 50 micrometers - 120 micrometers preferably.

[0017]As the outline sectional view of the example is shown in drawing 2, an information storage side considers the optical recording medium by other gestalten by this invention as the composition by which 1st at least one or more information storage sides 11A and the 2nd information storage side 11B were laminated via the interlayer 16 by a light transmission layer, respectively. When based on this composition, the sum of the thickness of the light

transmission layer which intervenes between the entrance planes of a laser beam from these each information storage side, and an interlayer shall be 3 micrometers - 182 micrometers. That is, for example with the composition of drawing 2, about the 2nd information storage side 11B, the sum of the thickness of the light transmission layer 12 and the interlayer 16 shall be 3 micrometers - 182 micrometers at the same time the thickness of the transmission layer 12 shall be 3 micrometers - 182 micrometers about the 1st information storage side 11A. And less than **5.26lambda/(N.A.) ^{4} carries out thickness unevenness of an entrance plane and an information storage side also in this case.

[0018]And about the 1st information storage side 11A. With the composition of above-mentioned drawing 1 having explained, similarly track pitch TP of the information storage side, It shall be referred to as 0.27 micrometer - 0.404 micrometer, shortest pit length P_{min} of an information storage pit shall be 0.13 micrometer - 0.219 micrometer, recording linear density LD shall be made into a pit sequence of 0.146micrometer/bit or less, and depth D of an information storage pit shall be 31 nm - 75 nm.

[0019]On the other hand, about the 2nd information storage side 11B, the track pitch TP sets to 0.45 micrometer - 0.57 micrometer, and shortest pit length P_{min} of an information storage pit sets to 0.21 micrometer - 0.31 micrometer, and makes recording linear density LD a pit sequence of 0.21micrometer/bit or less. Depth D of an information storage pit may be 57 nm - 113 nm.

[0020]Concerning [and] the 1st information storage side 11A, The wavelength lambda. Irradiate with the laser beam which is 380 nm<=lambda <=450nm through a 0.76 or more N.A. (numerical aperture) optical system, and about the 2nd information storage side 11B, The wavelength lambda. It irradiates with the laser beam which is 635 nm<=lambda <=680nm through a 0.76 or more N.A. (numerical aperture) optical system, and it is considered as the composition of record or reproduction which makes either at least, respectively.

[0021]The composition is further explained about the optical recording medium by above-mentioned this invention. First, the 2nd information storage side 11B where reproduction or/, and record are made by the laser beam of the wavelength range of red is explained. In already proposed DVD (Digital Versatile Disc or Digital VideoDisc), In the field of an information signal part (i.e., within the limits with a radius [a center to] of 24 mm - 58 mm), wavelength is 0.65 micrometer, a numerical aperture (N.A.) is 0.6, and the storage capacity is 4.7 GB. Therefore, 8/=[4.7] {(N.A./0.6) x (0.65/lambda)} ^{2} since capacity (in this case, density) is proportional to N.A. and it is effective by that square in inverse proportion to wavelength, in order to realize the storage capacity of 8 GB on the basis of this ... (1)

********** -- it is made like.

[0022]as the laser of the wavelength range of red -- the wavelength lambda --

635nm<=lambda<=, although there are specifically 680 nm of laser beams (0.635 micrometer, 0.650 micrometer, and 0.680 micrometer), In the above-mentioned (1) formula if [a lambda= 0.635-micrometer laser beam with short wavelength will be used among these, considering high recording density-ization, and] lambda= 0.635 micrometer 8/=[4.7] {(N.A./0.6) x (0.65/0.635)} ^{2} ... (1 $_{1}$)

It is set to next door and N.A.=0.76.

[0023]And each track pitch P and shortest pit length P_{min} for attaining the storage capacity of 8 GB in this lambda= 0.635 micrometer and N.A.=0.76, and line density LD, In a track pitch, 0.74 micrometer and shortest pit length in 4.7 GB of DVD 0.40 micrometer, Since the line density is 0.267micrometer/bit, a modulation method is premised on EFM in consideration of the both sides of the line direction of a track, and the cross direction, It is set to TP=0.74/root(8/4.7) =0.57micromP_{min}=0.40/root(8/4.7) =0.31micromLD=0.267/root(8/4.7) =0.21micrometer/bit.

[0024]From the relation of a formula (1 $_{1}$) to and TP=0.74/since about N.A.=0.95 can use by considering it as 2 group lens constitution as a lens system so that it may mention later (0.95/0.6x0.65/0.635)

= 0.45micrometer P_{min}=0.40/(0.95/0.6x0.65/0.635)

= 0.24micrometer LD=0.267/(0.95/0.6x0.65/0.635)

= It becomes in bit and 0.16micrometer /, and make [track pitch TP] recording linear density LD 0.24 micrometer - 0.31 micrometer with a pit sequence of 0.21micrometer/bit or less for shortest pit length P_{min} in this invention at 0.45 micrometer - 0.57 micrometer.

[0025]Here, the modulation method of an EFM (2-7) system and one to 7 system is one of the modulation methods for optical discs, and the ratio of the shortest pit length:channel bit length:signaling bit length of each method is 4:2:3 by 3:1:2 and 1-7 system in an EFM system. If one to 7 system is used from this relation in the case of the same density, pit length will decrease in number to eight ninths. A shortest pit will be set to 0.12 micrometer if this is hung.

[0026]On the other hand, depth D of a pit in that a modulation factor becomes the maximum by one fourth of the wavelength lambda when the deepest, and the shallower one. From the push pull signal in the push pull method well known for lambda/8 as one of the servo systems of a tracking error growing into the maximum. To be these ranges are demanded and it is set to 680/4/1.5=113nm635/8/1.5=57nm from this about the long wave length of 680 nm of the red laser mentioned above, and the short wavelength of 635 nm. That is, in this invention, depth D of a pit may be 57 nm - 113 nm.

[0027]On the other hand, about the information storage side 11A, compare with a red laser beam and The laser beam of short wavelength, That is, a laser beam (430 nm for example, using the SHG (second harmonic generation) element of 450 nm or less of short wavelength,

400 nm of a semiconductor laser, and also 380 nm) is used from blue or this, and it is in this case, [0028]

TP=0.74x (0.45/0.65x0.6/0.76)

= 0.404micrometer P_{min}=0.40x (0.45/0.65x0.6/0.76)

= 0.219micrometer LD=0.267x (0.45/0.65x0.6/0.76)

= It becomes in bit and 0.146micrometer /.

[0029]And TP=0.74x since about N.A.=0.95 can use by considering it as 2 group lens constitution as a lens system so that it may mention later (0.38/0.65x0.6/0.95)

= 0.27micrometer P_{min}=0.40x (0.38/0.65x0.6/0.95)

= 0.14micrometer LD=0.267x (0.38/0.65x0.6/0.95)

Become in bit and 0.09micrometer /and = About the information storage side 11A, Recording linear density LD is made [track pitch TP] 0.27 micrometer - 0.0.404 micrometer with a pit sequence of 0.146micrometer/bit or less for shortest pit length P_{min} at 0.14 micrometer - 0.219 micrometer.

[0030]Since it is set to eight ninths by 1-7 system like the above-mentioned about shortest pit length, it is set to 0.13 micrometer.

[0031]On the other hand, tolerance (skew margin) SM of the inclination of an optical recording medium to the optic axis of an irradiation laser beam, It is necessary for the light transmission layer 12 by which the laser beam which goes to the information storage side 11 is penetrated to make the thickness t small, when enlarging N.A., since it has a relation of SM**lambda/(N.A.) ^{3}/t. And about this skew margin SM, it is |SM|<=84.115 degree (lambda/(N.A.) ^{3}/t) by JP,3-225650,A.

It is known that what is necessary is just to be in ******.

[0032]This can be applied also to the optical recording medium of this invention, and it is appropriate to this SM to consider it as 0.4 degree as concrete full limits. Now, SM = it is seen as how much the thickness of a light transmission layer should be set by the short wavelength formation of laser, and high N.A.-ization as 0.4 degree. If compatibility with lambda= 0.38 micrometer of the purple-blue laser of short wavelength is further taken into consideration as a laser beam, supposing it will not change the conditions of 0.76 or more and ** of having mentioned N.A. above, thickness t of a light transmission layer will be set to t= 182 micrometers.

[0033]On the other hand, the minimum of the thickness of a light transmission layer is determined by whether the protection feature of the light transmission layer which also has a role which protects record film and a reflection film is secured. That is, if the influence [with the reliability and 2 group lens mentioned later of an optical recording medium] of the collision with the light transmission layer surface by approach of the lens to a light transmission layer in a

raise in N.A. is taken into consideration, it is required to be not less than 3 micrometers. Then, in this invention, thickness t of a light transmission layer shall be 3 micrometers - 182 micrometers.

[0034]High degree of accuracy is needed also about the thickness unevenness of a light transmission layer. When the thickness of a light transmission layer shifts from the design center of a reproduction object lens, the aberration amount which the thickness unevenness gives to a laser beam spot is proportional to the 4th power and the wavelength lambda of N.A. Therefore, when attaining high recording density-ization by a raise in N.A., or short wavelength formation, the thickness unevenness of a light transmission layer is restricted still more severely. In the case of CD, N.A.=0.45 is put in practical use as a concrete example of a system, and the standard of the thickness unevenness of a light transmission layer (in CD, it is a substrate) is **100 micrometers. In the case of DVD, the thickness unevenness same at N.A.=0.6 is specified as **30 micrometers, respectively. If based on the permissible dose of **100 micrometers in CD, thickness unevenness deltat will become like a following formula. deltat=**(0.45/N.A.) ^{4}x(lambda/0.78) x100 =**5.26x(lambda/(N.A.) ^{4}) mum[0035]In large-scale-izing in an above-mentioned optical recording medium, when obtaining SM with thickness t of the light transmission layer of N.A.=0.85 comparable as skew margin SM in now and DVD, to be less than 0.6x(0.6/0.85) ^{3}=0.21mm is demanded. When compatibility with the purple-blue laser whose wavelength is about 400 nm is taken into consideration, it is set to 0.21x0.4 / 0.65= 0.129 mm, and thickness t of a light transmission layer will be 0.12 mm or less.

[0036]And in order to actually form this light transmission layer 12, spreading of resin and adhesion of a resin sheet can be considered, for example, but in the method of applying resin, generating of the skew by the contraction at the time of hardening of this resin and upheaval of the outermost periphery part by carrying out spin coating of the resin pose a problem. Then, as the outline sectional view in other one gestalt is shown in drawing 3, it is considered to be an effective method to paste up and form the transparent resin sheet 14 by the transparent glue line 15, but. In this case, as for thickness t of a light transmission layer, if a resin sheet becomes thinner than 50 micrometers, since a double reflex will be large and influence will arise in a signal characteristic, it is preferred that it is not less than 50 micrometers. In addition, as for thickness t of this light transmission layer, it is preferred also from adhesion of the garbage in a light transmission layer, the influence on the record reproduction laser beam spot by generating of a crack, and the instability of the servo by this that it is not less than 50 micrometers.

[0037]Since it mentioned above, it will be more preferred that thickness t of a light transmission layer sets to 50 micrometers - 120 micrometers.

[0038]The sequence of the above-mentioned pit P in an optical recording medium [in / for explaining the composition of the optical recording medium by this invention / this invention],

As the outline pattern drawing is shown in drawing 4, and it has composition which is shown in drawing 4 A and which was formed on the singular number, i.e., one spiral wire, or is shown in drawing 4 B, in plurality and the example of a graphic display, it can have composition formed on two spiral wires.

[0039]As the outline pattern drawing is shown in drawing 5, it can also have composition with which the record feasible region 40 which attaches and shows a slash was established in fields other than the formation part of the information pit P of the information storage sides 11A and 11B. In the pit sequence mentioned above, this record feasible region 40 can be similarly made into the singular number or two or more spirals.

[0040]When it has composition of plurality (two parallel spirals), for example, a double spiral etc., It can have composition of forming the pit P which forms the groove of spiral shape, and forms a record feasible region in so-called each with the land between the inside of this groove, and a groove, or constitutes a ROM part, for example to a land.

[0041]drawing 6 A -- the groove Grv of the spiral shape which attaches and shows a slash so that the outline pattern drawing may be shown, [form and] As it has this groove Grv and composition which forms pit sequence P on each extension of the land Lnd in the meantime, respectively or is shown in drawing 6 B and C, The groove Grv and the land Lnd can also have composition formed continuously, and can consider it as various arrangement configurations -- it can have composition which forms the sequence of the pit P on the extension.

[0042]As mentioned above, when it has composition by which the 1st and 2nd information storage sides 11A and 11B that differ in composition, respectively were laminated, laminating formation can be carried out, for example via the interlayer 16 by ultraviolet curing resin.

[0043]In this case, thickness t of the light transmission layer to the 2nd information storage side 11B becomes the sum of the interlayer 16 and the surface light transmission layer 12, as mentioned above.

[0044]And it is preferred to arrange the information storage side 11A considered more as short wavelength correspondence in this case to the side which approaches the incidence side of a laser beam, i.e., the object lens of optical recording playback equipment, from the 2nd information storage side 11B. This is because a skew margin becomes severe more in connection with short wavelength formation.

[0045]A reflection film is formed in the information storage side 11A by a pit sequence according to ROM composition so to speak in each above-mentioned composition. And when considering it as the multilayer structure by which the information storage side was laminated, the reflection film by the side of laser incidence presupposes that it is translucent. In a record feasible region, the rewriting possibility of or one time can write in, and it can have what is called WO type composition, For example, when considering it as what is called a phase change type by the record mode from which the optical property by change between

polycrystal-ized-amorphous changes with laser radiation, a phase change material layer is formed and it changes. Also in this record feasible region, a reflection film can be formed in that forming face, i.e., a groove, and a land side if needed.

[0046]In each example mentioned above, it can also be considered as the structure which laminated the information storage side 11A to the multilayer, and is not restricted to the example of a graphic display -- it can be considered as the structure which carried out multilayer lamination of the 1st and 2nd information storage sides 11A and 11B, respectively.

[0047]The information storage side 11A which the optical recording playback equipment by this invention mentioned above, Or using each optical recording medium M, for example, an optical disc, which has the 1st and 2nd information storage sides 11A and 11B, it is optical recording playback equipment which performs the playback or/and record over this and which is performed optically, and the lineblock diagram of the important section of the example is shown in drawing 7. For example, to the optical recording playback equipment to the optical recording medium which has only the information storage side 11A, are and it sets, It has a laser light source section (not shown) which can obtain the laser beam of the wavelength lambda of the range of 380 nm<=lambda <=450nm, It enters in the direction which intersects perpendicularly to the optical recording medium M which rotates this laser beam L through a 0.76 or more N.A. (numerical aperture) optical system, i.e., an object lens, from the light transmission layer 12 side mentioned above, and reproduction or/and record of the recorded information on that information storage side are carried out to it.

[0048]The recording and reproducing device with which the reproduction or/to the optical recording medium which has the 2nd information storage side where the 635 nm<=lambda <=680nm laser beam mentioned above is used, and record are made, making into the 1st light source part the laser light source section (not shown) which can obtain the laser beam of the wavelength lambda of the range of 380 nm<=lambda <=450nm mentioned above, as similarly shown in drawing 7 -- for example, this -- both, Provide the light source part (not shown) of 635 nm<=lambda <=680nm laser beam L as the 2nd light source part, and the optical recording medium M is received, About both laser beams, they are any of the 1st and 2nd information storage sides 11A and 11B. It has composition with which it switches and irradiates by whether reproduction or/, and record are performed to an information storage side.

[0049]And as an optical system of each above-mentioned optical recording playback equipment, 2 group lens systems 31 and 32 can constitute, and high N.A. can be obtained by doing in this way. The single lens which has the lens side 31a which has a necessary curved surface, respectively, and 31b, 32a and 32b not only constitutes these lens systems 31 and 32, but it can form it as a lens group with two or more lenses, respectively.

[0050]2 group lens systems 32 and 33 in this optical system can be considered as the composition which changes a mutual interval so that changing adjustment is possible. Thus, by

having variable composition, the wavefront aberration produced when the thickness of a light transmission layer changes can be negated, and the simplification of a design and manufacture, the stabilization of record reproduction, and the improvement in the characteristic in an optical recording medium and optical recording playback equipment can be aimed at by this.

[0051]As mentioned above, according to this invention, the optical recording device which performs the optical recording medium which can enable mass record of 8 GB, for example, its reproduction or/, and record can be constituted, stopping the skew margin, grade [in DVD].

[0052]Although it is a case where an information storage side is formed in one field of the substrate 10 one or more layers, in the optical recording medium mentioned above, Thus, in [can also form a both-sides type optical recording medium by pasting together the two substrates 10 with which the information storage side was formed, respectively to the side in which each information storage side was formed in an opposite hand, and] the optical recording playback equipment according to this, An optical recording medium and optical recording playback equipment according "Don't have composition which irradiates with a laser beam to the information storage side of these both sides, respectively" to this invention can make various modification change.

[0053]In this specification, it is needless to say in transparence and light transmission, and the designation of what has permeability to the laser beam used is carried out.

[0054]

[Effect of the Invention]In the optical recording medium which performs reproduction or/, and record according to this invention as mentioned above, The optical recording device which performs the optical recording medium which can enable mass record of 8 GB, for example, its reproduction or/, and record can be constituted stopping the skew margin, grade [in DVD].

[Translation done.]